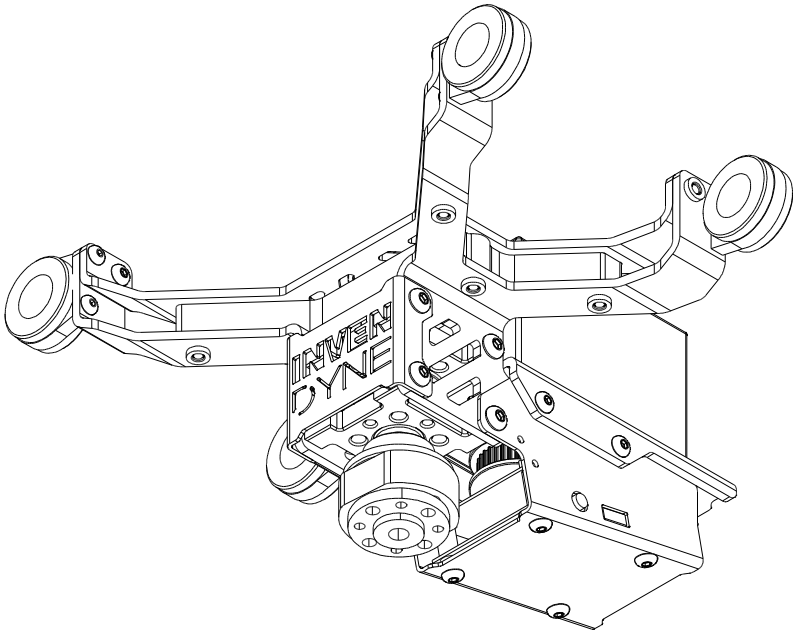
INVEN DYNE

PANO360 – AUTOMATED PANORAMIC GIMBAL



USER'S MANUAL

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1. A brief overview of the device

Pano360 is a multirotor add-on for making panoramic photos with a press of a button. If an automatic device to make multiple aerial panoramas is needed – this is the way to go. Pano360 is a panning gimbal with integrated electronics that control the rotation angle and camera trigger.

Bellow is a graphic showing the key elements of the device. This graphic will be used as reference throughout this manual:

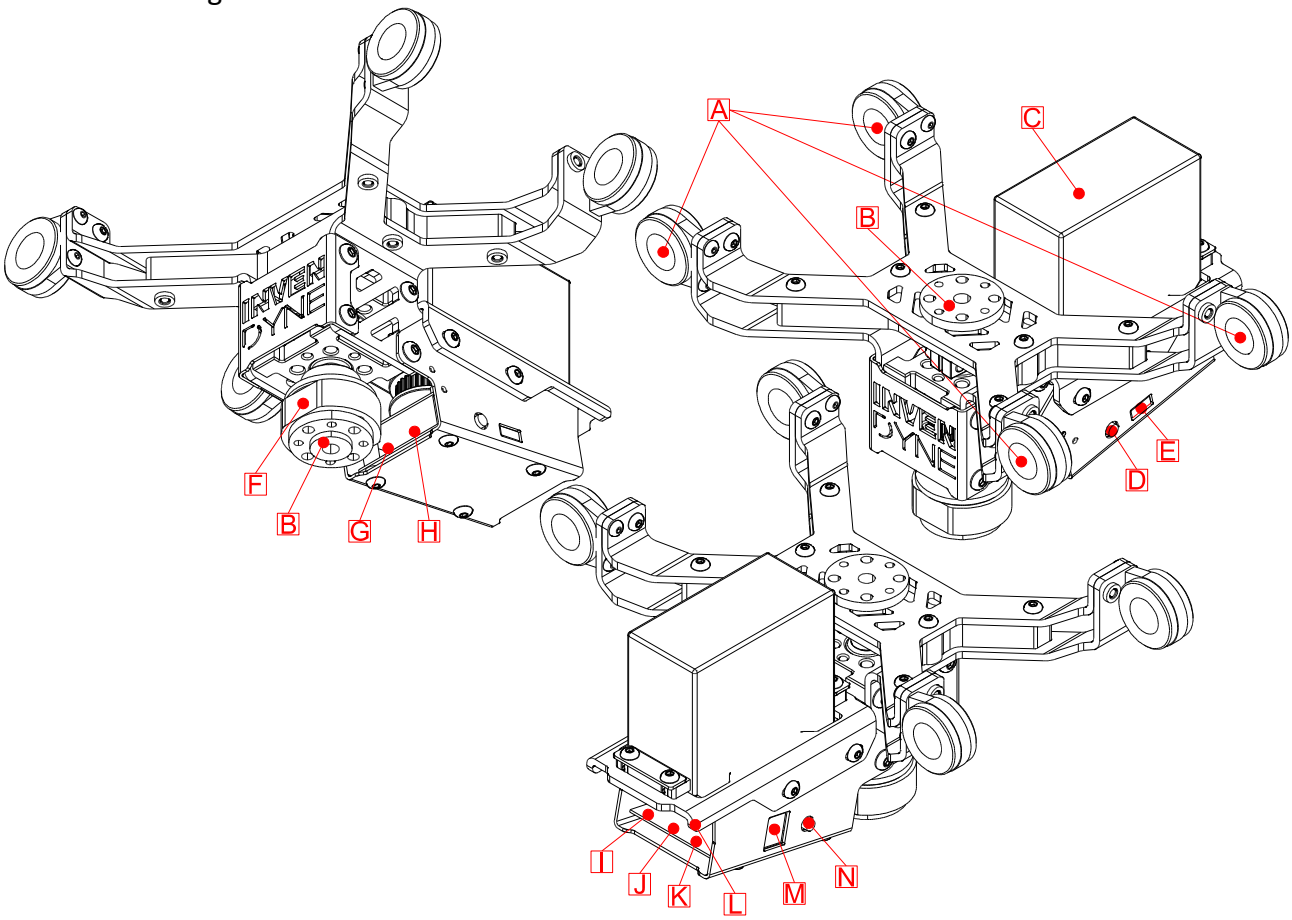


Fig. 1 Pano360 overview.

A – aluminium rings with rubber grommets, Pano360 to DJI S800/S1000 H-Frame mount
B – ¼ UNC thread plate that can be placed both on top and bottom, this is useful for mounting Pano360 on a tripod or connecting it with a panorama head other than Nodal Ninja
C – custom servo motor
D – cable camera shutter and auto-focus output, 2.5 mm jack socket
E – Pano360/PC communication, micro USB socket
F – mounting hub for Nodal Ninja Ultimate R1/R10 or ¼ UNC thread plate
G – wireless camera shutter control, infra-red transmitter connector
H – servo motor output, 3-pin header male connector
I – panoramic sequence trigger, 1st RC input, 3-pin header male connector
J – manual servo control, 2nd RC input 2, 3- pin header male connector
K – remote preset selection, 3rd RC input 3, 3-pin header male connector
L – power connector, 3-6s batteries can be used
M – character display (segment display)
N – manual preset selection button, the device has the capacity to store 10 different presets

2. Getting started, step-by-step

To get your Pano360 up and running you will need:

- a PC with Windows XP, Vista, 7 or 8,
- a micro USB cable (most modern mobile phones have this type of cable for charging),
- a camera that can be triggered by cable or by infra-red signals,
- a set of hex keys,
- a tilt head (preferably a Nodal Ninja Ultimate R1 or Nodal Ninja R10),
- a shutter cable with mini jack (2.5 mm) on one side and a camera matching connector on the other side or an infra-red transmitter module (optional for purchase),
- a multirotor such as DJI S800/S1000 with a radio transmitter (for examples: HiTec Aurora9, Futaba 8J, JR P00634 etc.) and a RC receiver (for example: HiTec Optima, Futaba R3008SB, JR PR790 etc.),
- at least one cable with 3 pin female header on both sides (aka. servo cable),
- a soldering iron to solder the power cables.

There are 5 steps you go trough to run Pano360:

1. **Install the software on your PC** (refer to **2.1**)
2. **Mount the Pano360 you the H-frame of your multirotor** (refer to **2.2**)
3. **Connect the cables** (refer to **2.3**)
4. **Configure the device parameters and make a test run** (refer to **3.**)
5. **Configure your RC radio transmitter** (please refer to the manual of your transmitter).

2.1 Software installation

Let's start with software installation.

- The latest software can be found here:

  www.invendyne.com

- Download InvendynePano360Setup.exe.
- Run InvendynePano360Setup.exe (double click the file).
- You may be asked if you want to install the software by an unknown publisher, click **Run**.
- You may also be asked if you want to install the program by an unknown published, click **Yes**.
- The installation wizard will pop-up, click **Next**.
- Click **Next** again (you may optionally enter a different folder for the installation).
- Click **Install**.
- Click **Finish**.
- Pano360 GUI and USB drivers are now installed.

2.2 Mechanical setup

Pano360 has a hub (**Fig.1-F**) which has a set of holes that can be used to mount a tilt head, a ¼'' UNC thread adapter or any other device that has a set of matching holes. M5 holes with a spacing of 22 mm are typically used to mount Nodal Ninja tilt heads. A common use for M3 holes with a spacing of 19.55 mm is attaching a ¼'' UNC thread adapter (**Fig. 1-B**).

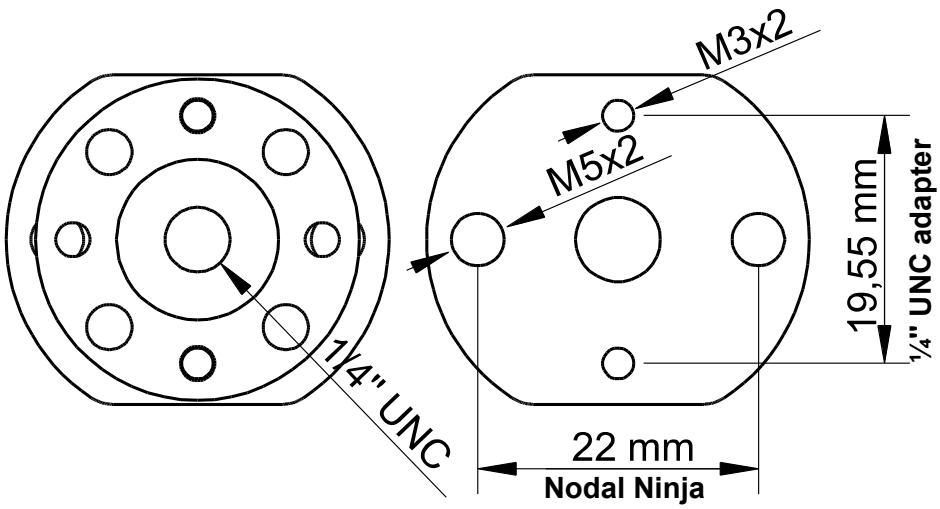


Fig.2 Hole types and spacing of the mounting hub.

When mounting the ¼'' UNC thread adapter to the hub we recommend using the provided M3 screws. Nodal Ninja comes with a set of M5 screws – it is best to use this screws to mount the tilt head to the hub.

Fig. 3 Pano360 with Nodal Ninja

To mount Pano360 to DJI H-frame it is best to remove the carbon pipes and slide them once again through all DJI elements and Pano360 rubber grommets (**Fig. 1-A**).

Fig. 4 Pano360 mounting to DJI H-frame.

2.3 Cable connection

Before making any connections there are 3 rules you should always apply:

1. When wiring Pano360 make sure all the connections are correct – if the cables are not connected correctly the on-board electronics may be damaged. Always double check that you have proper connections.

2. Make sure the cables are long enough and there is nothing in the way of the camera (for example retractable legs) so the whole 360° turn can be made.

3. Before connecting any signal cables, make sure the multirotor battery is disconnected. Connecting / disconnecting signal cables while the multicopter is powered can damage the pano360 and/or the radio receiver.

2.3.1 Servo connection

Start by making sure the servo motor (**Fig. 1-C**) cable is properly connected to the servo output (**Fig. 1-H**)**.** The white cable should be facing inward and all the pins should be connected.

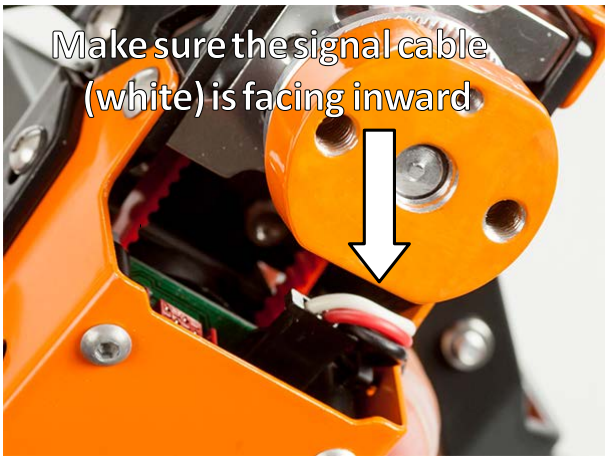


Fig. 4 Servo cable connection

2.3.2 Digital input connection

There are two modes of operation **automatic** and **manual**. For each mode you will be required to connect the RC inputs (**Fig. 1-I-J-K**) with your radio receiver using a 3 pin female header cable. The automatic mode enables making panoramas with a press of one button whereas the manual mode allows to control the rotation by hand with a joystick.

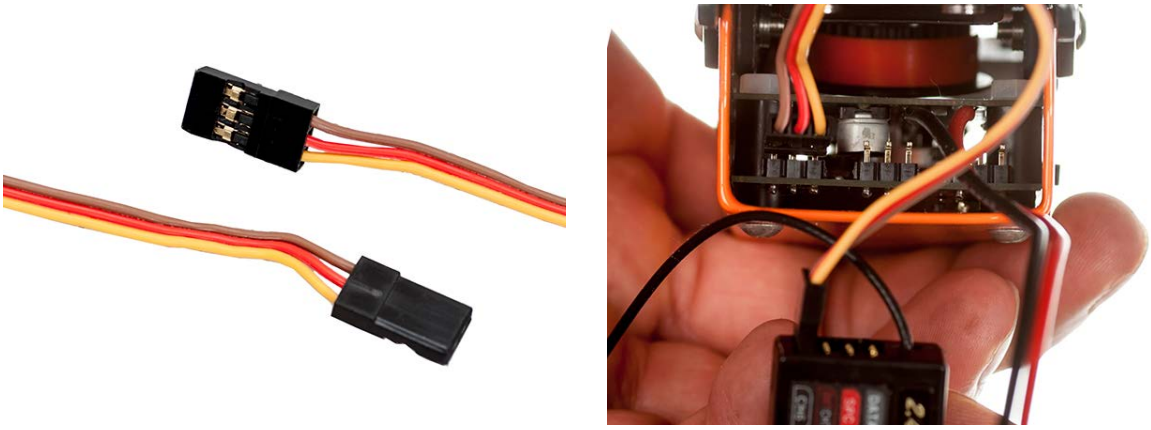


Fig. 5 – A cable with 3 pin female header on both sides / cable connection with a RC transmitter

If you want to run Pano360 in automatic mode, connect the 1st digital input (Fig.1-I/Fig. 6) with your RC receiver. You can optionally connect the 3rd digital input (Fig.1-K/Fig.6) for remote preset selection. Make sure the yellow (or white) cables for each connector are on the right side for each connector (Fig. 6).

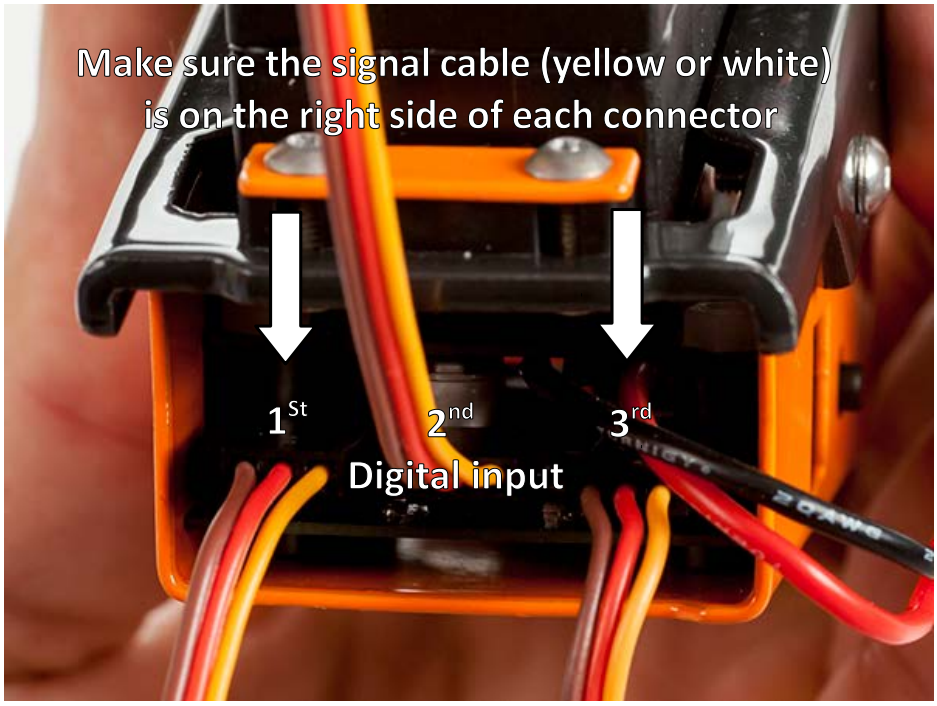


Fig. 6 Automatic mode connection example

If you want to control Pano360 manually then you need to connect the 1st digital input (Fig.1-I/Fig.7**)** and the 2nd digital input (Fig.1-J/Fig.7).

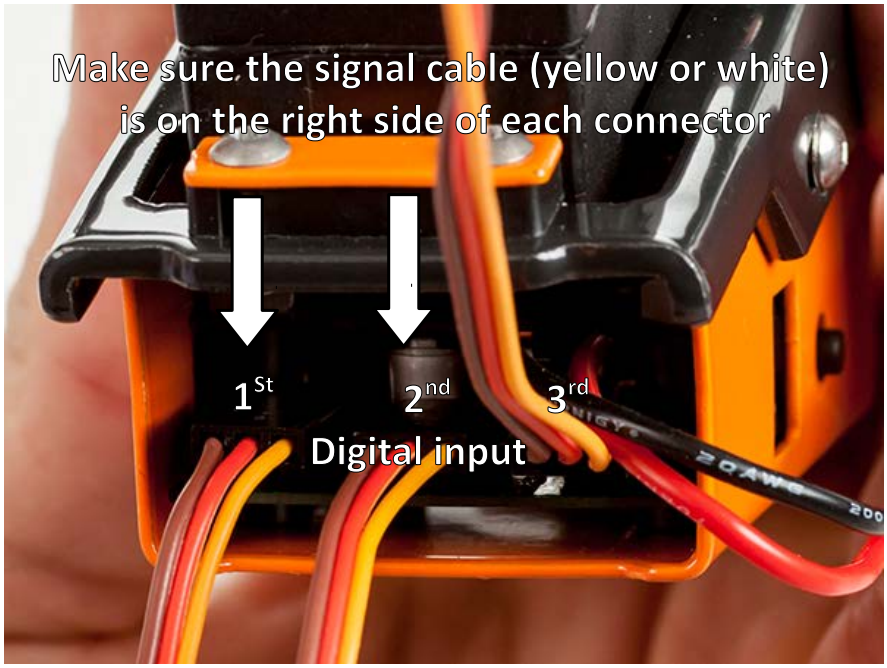


Fig. 7 Manual mode connection example

At this point you may want to bind your RC receiver with the RC transmitter if you haven't already done so. Do configure your RC transmitter to trigger the channels that correspond to Pano360 inputs. Please refer to your transmitter manual for more information on how to setup the channels for your RC transmitter.

2.3.3 Camera trigger connection

For infra-red camera triggering connect the IR transmitter to the micro-match connector (**Fig. 1-G**/**Fig.8**). Alternatively, for wire triggering use a cable that matches you camera type and has a 2.5 mm jack on the other end. This cable should be connected to the input on the side (**Fig. 1-H**/**Fig.8**). **Please make sure the appropriate camera triggering option (cable/infra-red) is enabled in your camera** – refer to your camera manual. Later you will need to enable the triggering option in the GUI (**Tab.3**).

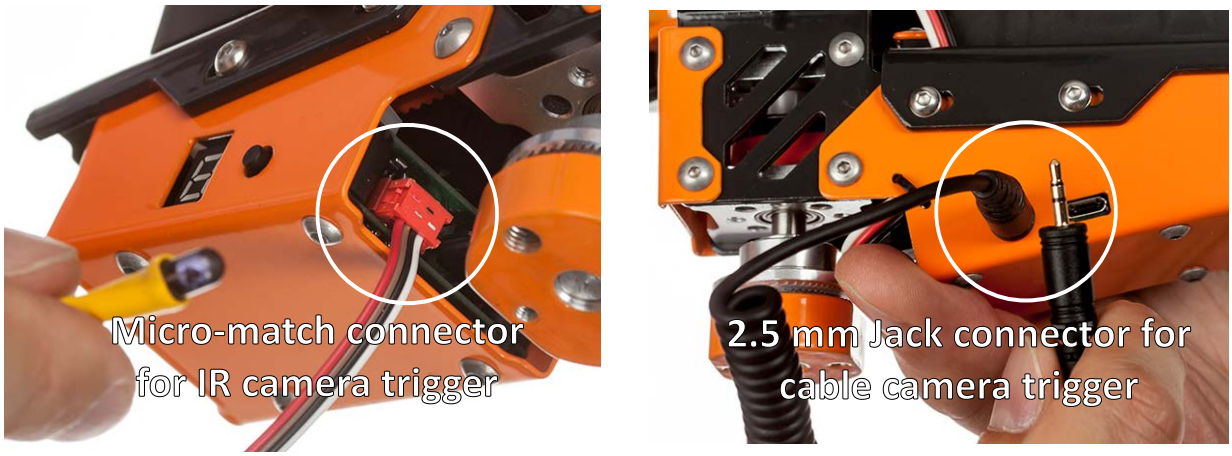


Fig. 8 Camera triggering outputs

2.3.4 Power connection

A soldering job is needed to connect the female side of the mini-T power connector (**Fig 1.-L**) with the supply of your helicopter. **Make sure to disconnect the battery while soldering**. When the soldering is done, connect the mini connectors. Now you can plug the main battery connector to power your multirotor and Pano360.

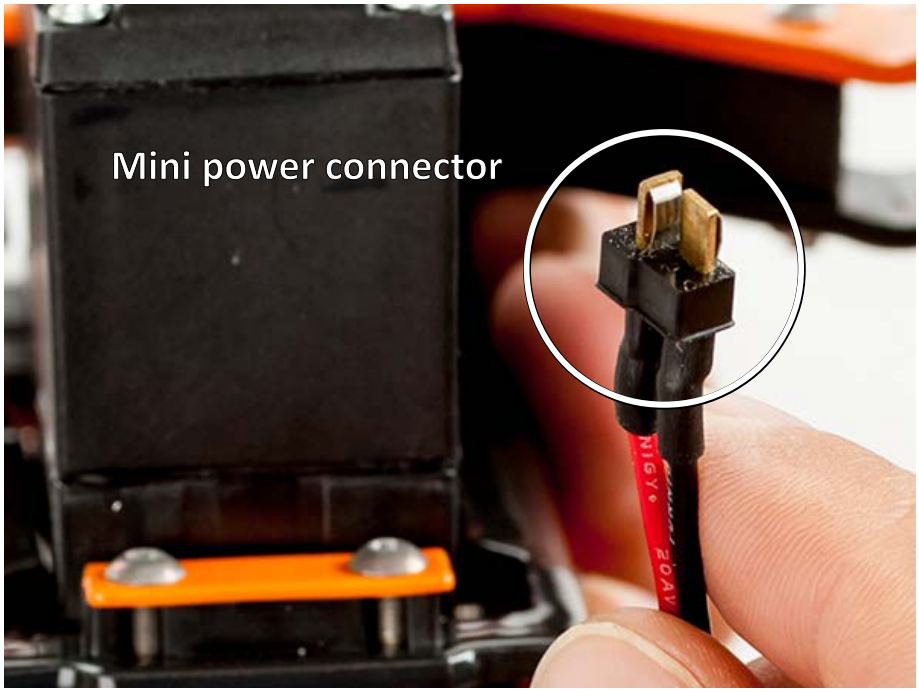


Fig. 9 Mini-T connector used to power Pano360

2.3.5 Pano360/PC connection

Lastly plug the micro USB connector on the side of the device (Fig 1-E/Fig. 10) and the other end of the cable to your computer. **All the connections for Pano360 are done. The device is ready for configuration and a test run.**

Fig. 10 Micro USB connector – Pano360/PC communication

3. Pano360 GUI

Pano360 GUI (**Graphic User Interface**) is a window application that lets you enter different parameters of the device. Below is a quick overview of the program.

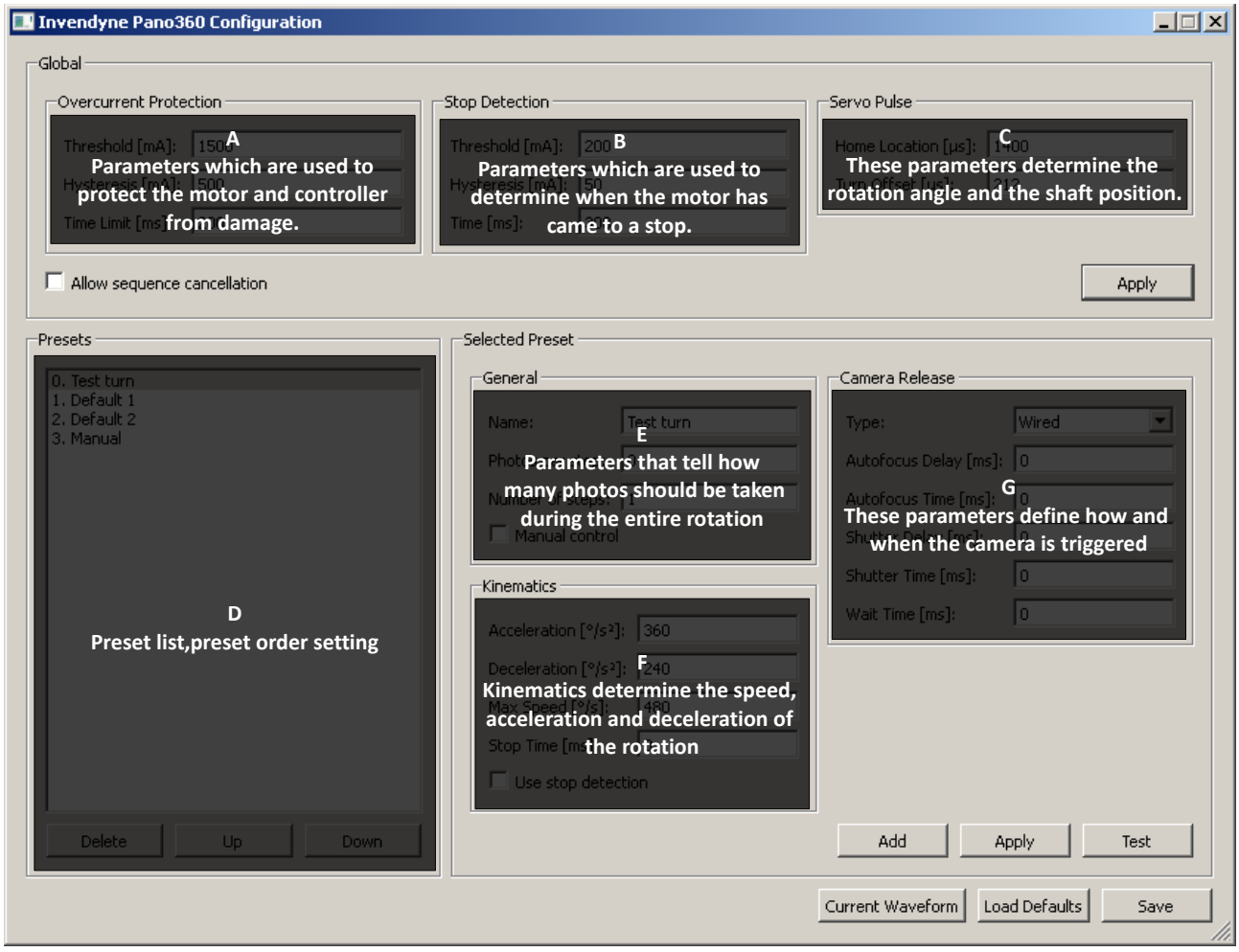


Fig. 11 Pano360 GUI overview.

3.1 Quick example on how to set the parameters in Pano360 GUI

To follow this example please make sure you have installed the software and everything is properly connected (refer to: **2.1**, **2.2**, **2.3** should something be missing). If the micro USB cable or the power supply (mini-T connector) are not connected the GUI will not be active. For this example we will be triggering the camera by cable – make sure you have a matching cable and the cable triggering is enable for your camera.

- Load the GUI – **Start** → **All Programs** → **Invendyne Pano360** → **Configuration**
- Do not change Overcurrent Protection and Stop Detection parameters.
- Leave Servo Pulse parameters (Home Location and Turn offset) for now, the default values might not be ideal but they should be pretty close.
- Select **Default 1** in the Preset list (**Fig. 11-D**).

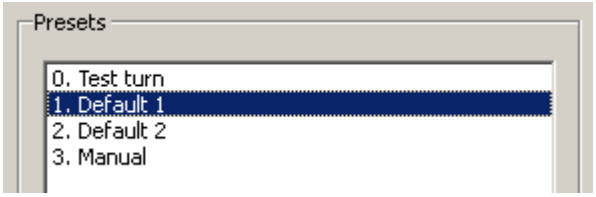


Fig. 12 Choosing presets for editing from the preset list in Pano360 GUI

- Set the values of **General, Kinematics** and **Camera Release** for the Selected Preset as shown below

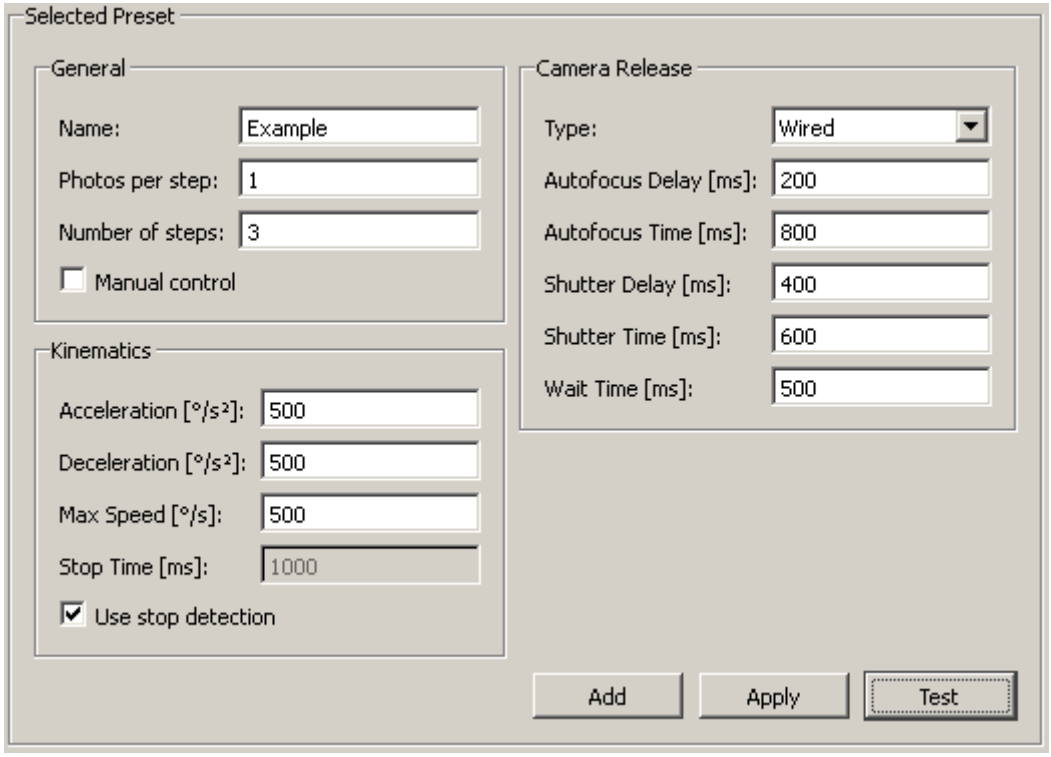


Fig. 13 A quick example on how to setup the Pano360 parameters.

- Click the bottom **Apply** button in the Selected Preset Section, all the parameters are instantly applied onto Pano360.
- Now click **Test** and notice the results.

In this example we have configured Pano360 to trigger an automatic panorama sequence that makes 1 photo per each turn (**Photos per step:1**). There are 3 turns with a roughly 120° angle (**Number of steps:3**). The rotation is made in a moderate speed (**Acceleration: 500, Deceleration: 500, Max Speed: 500**). **Stop detection is active** to enable the driver to determine

when the rotation has come to a fulls stop. The camera is triggered by wire (Camera Release **Type: Wired**). When the camera stops at each turn there is a 200 ms delay and the autofocus signal is active for 800 ms (**Autofocus Delay 200, Autofocus Time 800**). Also when the camera is stopped there is a 400 ms delay before the shutter signal becomes active for 600 ms (**Shutter Delay: 400, Shutter Time: 600**). When the autofocus and shutter signals are no longer active there is a 500 ms delay before the next step is made (**Wait Time:500**). The camera is stopped at each step for about 1500 ms.

You may notice that the whole angle of rotation is not exactly a 360°. To fine-tune the sequence angle please refer to (**3.2.1**).

3.2 Global settings

Global setting are a group of parameters that are applied to all the presets. The two most commonly used parameters are the ones located in the Servo Pulse group: Home Location and Turn Offset. Do not bother changing Overcurrent Protection and Stop Detection values unless the default values do not work for you.

3.2.1 Servo Pulse

Servo Pulse (**Fig. 11-C**) consists of 2 parameters. The first is **Home location** – this variable determines the initial shaft position and will be frequently adjusted – every time you decide to detach the collet from the shaft or the belt skips. Servo pulse can be changed within 750-2250 µs range. It is best to start with home location set to 1400µs. Enter 1400µs value as Home Location and click Apply in the Global Settings section to confirm. Depending on your needs, the shaft (camera front) angle can be adjusted. For example, if you want the shaft to rotate **clockwise (CW)**, lower the value of Home Location in 10 µs increments (1390µs, 1380µs, 1370µs etc.) and notice how the shaft is rotating **CW**. By increasing Home Location in 10µs increments (1410µs, 1420µs, 1430µs etc.) the shaft will be rotating **counter clockwise (CCW)**.

We advise you to change the home location in small increments (4-30µs) until you get the desired position of your camera. 60µs is about 90° turn.

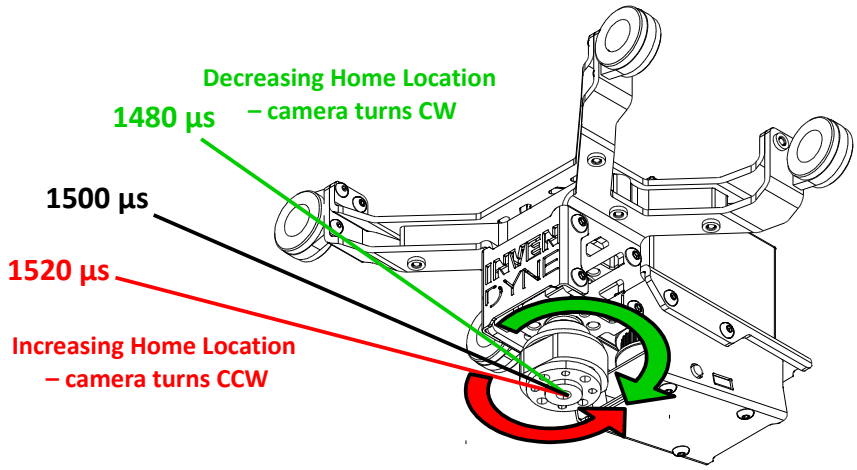


Fig. 14 Home location adjustment example

The second parameter is **Turn Offset** – this parameter defines the angular rotation for the whole panoramic sequence. Turn Offset value is added to Home Location and as a result the servo turns the shaft by a desired angle. Home Location is the reference position for Turn Offset.

To make a 360° turn we recommend you set **Turn Offset to 220µs**. Enter this value and click **Apply** in the Global Settings section. You may use **Test turn** preset to see how the shaft rotates.

Select this preset from the list, click **Apply** in the Selected Preset group and then click **Test**. If the shaft does not make a 360° turn you will have to adjust this parameter manually. Do experiment. The 360° turn should be within the 205-235µs range.

Should you require a different angle, here are some Turn Offset values for reference:
- a Turn Offset of ~120 µs will result in a 180° turn,
- a Turn Offset of ~435 µs will result in two whole turns (720°).

3.2.2. Overcurrent Protection

Note: do NOT change this parameter if you have no prior experience. Before changing this parameter make sure you read and understand this chapter.

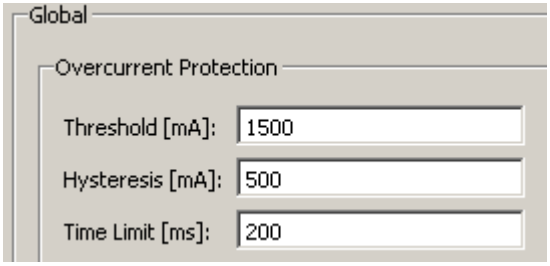


Fig. 15 Default overcurrent protection settings

The aim of overcurrent protection (Fig. 11-A) is to protect the drive and electronics from damage. The motor draws high currents when:

a) the drive gets blocked – this usually happens when the camera hits the landing gear during operation or something gets stuck between the pulleys and the belt,

b) the load is high and the driving parameters are too aggressive – a heavy camera is used and the Acceleration and Max. Speed parameters (Tab.2) are too high for the load.

Pano360 electronics has the ability to detect high currents that are drawn by the servo in the above scenarios. **If, during operation, the current value exceeds the Threshold and does not drop below Threshold minus Hysteresis within the Time Limit then the motor will be turned off and that should hopeful protect Pano360 from damage.**

You can view the current waveforms by clinking **Current Waveform** at the GUI bottom. Current waveform show how much current is drawn over time by the servo motor during operation.

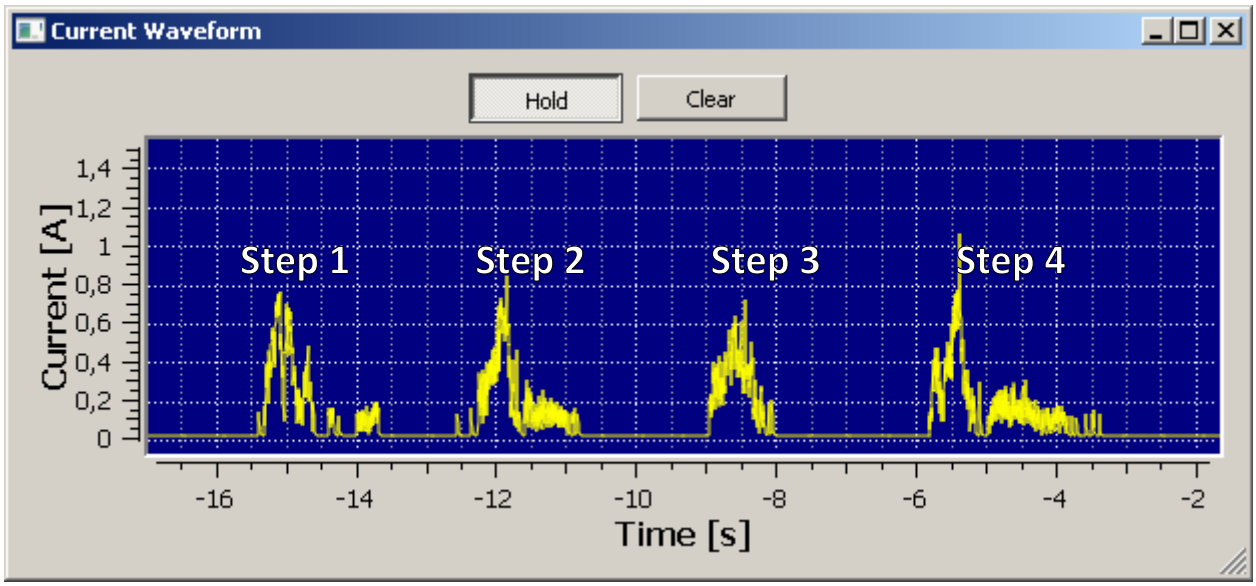


Fig. 16 Waveform example, Number of steps=4, Acc.:500, Dec:500, Max Speed:500, Load: 1.6 kg

Below are 3 examples of how the overcurrent protection works.

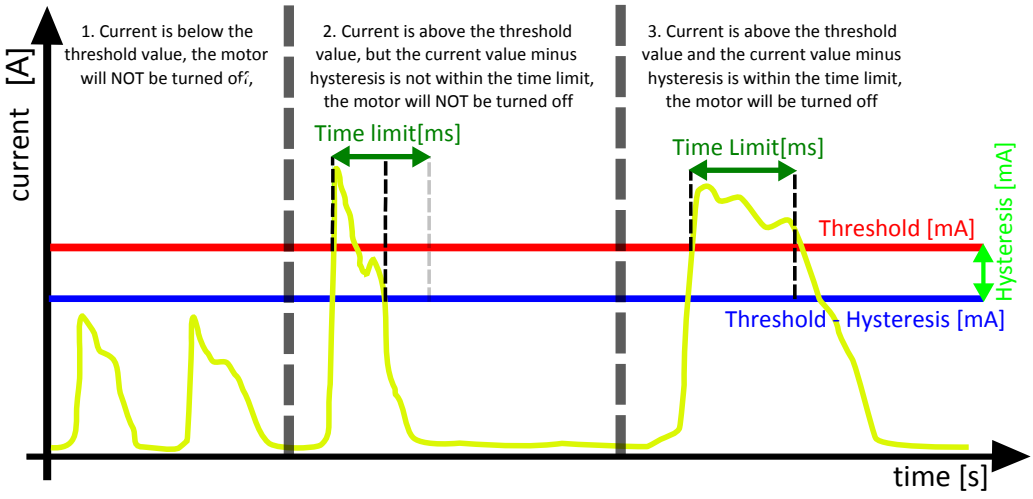

current [A]
1. Current is below the threshold value, the motor will NOT be turned off,
2. Current is above the threshold value, but the current value minus hysteresis is not within the time limit, the motor will NOT be turned off
3. Current is above the threshold value and the current value minus hysteresis is within the time limit, the motor will be turned off
Time limit[ms]
Time Limit[ms]
Threshold [mA]
Hysteresis [mA]
Threshold - Hysteresis [mA]
time [s]

Fig.17 Overcurrent protection examples

3.2.3. Stop Detection

Note: do NOT change this parameter if you have no prior experience. Before changing this parameter make sure you read and understand this chapter.

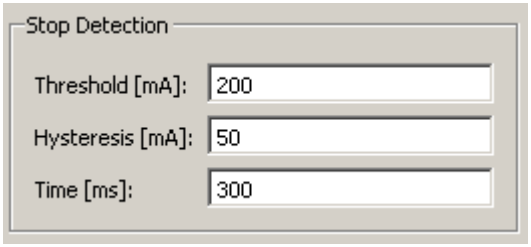


Fig. 18 – Default stop detection settings

Stop detection (**Fig. 11-B**) is a function that tells the driver when the rotation comes to a stop. Stop detection allows the driver to tell when to make a stop at each step. **If, during operation, the current drops below the Threshold value and remains below Threshold plus Hysteresis within Time, then the controller assumes that the motor has stopped.**

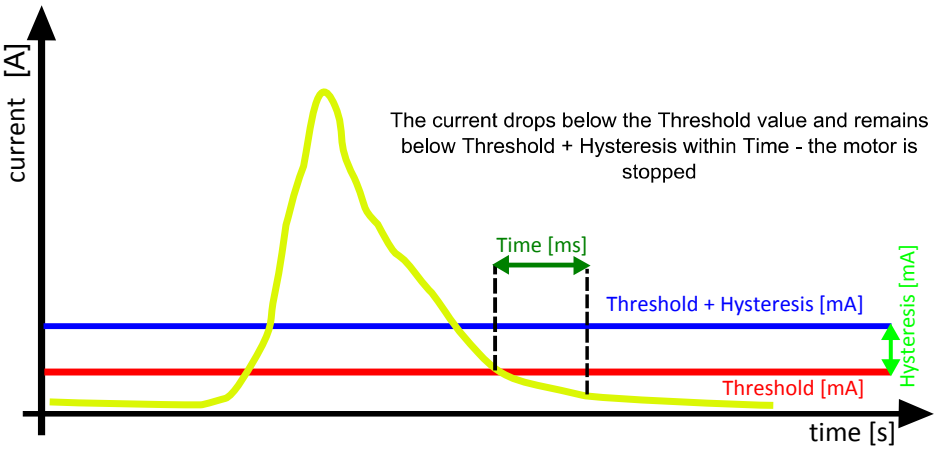

current [A]
The current drops below the Threshold value and remains below Threshold + Hysteresis within Time - the motor is stopped
Time [ms]
Threshold + Hysteresis [mA]
Hysteresis [mA]
Threshold [mA]
time [s]

Fig. 19 Stop detection example

3.3 Making user presets

Presets are user settings that help make great photos every time you launch the panoramic sequence. The parameters ensure a consistent result for all the photos that are captured during flight. Let's go quickly through all the parameters:

Name	Preset name, any set of 16 characters to name the preset. The name is displayed in the panel, which allows an easier identification.
Number of steps	This parameter defines the number of camera stops to be made for each panoramic sequence. The whole sequence is evenly divided by the number of steps. **Think of this parameter as a number of grooves in a detent ring of a panoramic rotor**. $\frac{Angle\ of\ the\ whole\ panoramic\ sequence[°]}{Number\ of\ steps} = Angle\ of\ rotation\ between\ stops[°]$ For example: if the panoramic sequence has a 360°degree turn, the number of steps set to 4 will result in stop at each 90°(360°/4=90°).
Photos per step	The number of photos to be made at each step. Each photo will be using the same Camera Release parameters (Autofocus Delay/Autofocus Time, Shutter Delay, Shutter Time).
Manual control	If the box is checked then the manual control is active, this means the rotation is controlled by hand with a joystick. Make sure you connect Pano360 properly for this mode (**Fig. 7**)

Tab. 1 General option for presets (**Fig. 11-E**)

Acceleration [°/s ²]	The rate of increase in speed from 0 to Max Speed. Lower values will result in a more smooth, sluggish operation – recommended for higher payloads. Higher value will result in a more speedy/aggressive operation – recommended if the payload is small and fast operation does not make the multirotor swing in the air. Value range: 0-9999, Acceleration = 1 - minimum acceleration Acceleration = 9999 - second highest acceleration Acceleration = 0 - maximum acceleration
Deceleration [°/s ²]	The rate of decrease in speed from Max. Speed to 0. Lower values will result in a more slower operation. Higher value will result in a more faster operation. Value range: 1-9999 Deceleration = 1 - minimum deceleration Deceleration = 9999 - second highest deceleration Deceleration = 0 - maximum deceleration
Max Speed [°/s]	The maximal angular speed of the movement. Lower values will result in a more slower operation. Higher value will result in a more faster operation. Value range: 1-9999 Deceleration = 1 - minimum value of Max Speed Deceleration = 9999 - second highest value of Max Speed Deceleration = 0 - maximum value of Max Speed
Stop time [ms] / Use stop detection	Stop time defines the time the motor needs to make a full stop between the steps. If “Use stop detection” is activated this setting is inactive and the full stop is determined based on Stop Detection settings (**3.2.3**).

Tab. 2 Kinematics options for presets (**Fig. 11-F**)

Type	Camera can be triggered by cable or by infra-red signals. Use Wired option to trigger the camera by cable or choose among a variety of infra-red protocols: Sony IR, Canon RC-1, Nikon IR, Pentax IR, Olympus IR, Minolta RC-3. Make sure to use the appropriate infra-red protocol for your camera.
Autofocus Delay [ms]	Delay time before Autofocus becomes active. Autofocus Delay is preceded by Stop Time. 1000 ms = 1 second. Value within the range of 0-9999 ms (**Fig. 20**). Value = 0 disables Autofocus Delay.
Autofocus Time [ms]	Time during Autofocus is active. Autofocus Time is preceded by Autofocus Delay. Value within the range of 0-9999 ms (**Fig. 20**). Value = 0 disables Autofocus Time.
Shutter Delay [ms]	Delay before Shutter becomes active. Shutter Delay is preceded by Stop Time. Value within the range of 0-9999 ms (**Fig. 20**). Value = 0 disables Shutter Delay.
Shutter Time [ms]	Time during Shutter is active. Shutter Time is preceded by Shutter Delay. Value within the range of 0-9999 ms (**Fig. 20**). Value = 0 disables Shutter Time.
Wait Time [ms]	An amount of time before the next step or next photo after Shutter Time and Autofocus Time have ended. This parameter is useful when you want to allow extra time for your SD card to save a photo (**Fig.20**).

Tab.3 Camera release options for presets (**Fig. 11-G**)

The total step time consists of Stop Time, Autofocus Delay, Autofocus Time, Shutter Delay, Shutter Time and Wait time. Below is an example on how this parameters affect the total step time. The segment display shows when autofocus and shutter are active, by lighting up the bottom left corner and the top right corner (**Tab. 4**).

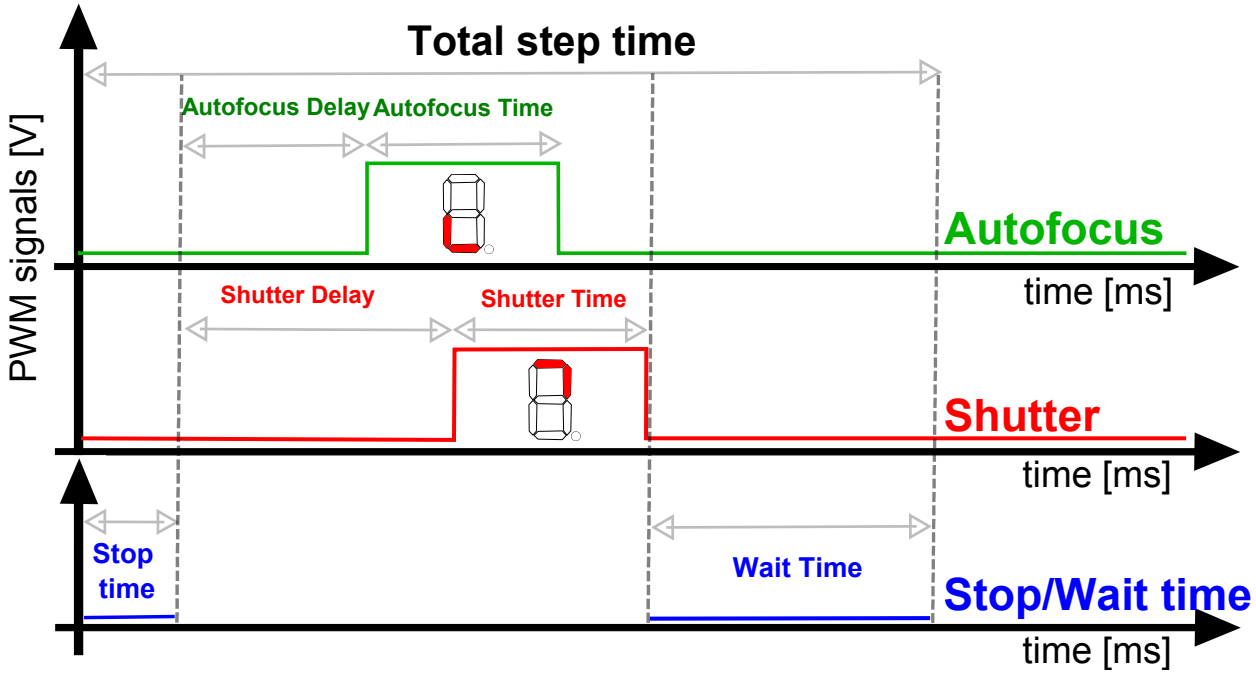
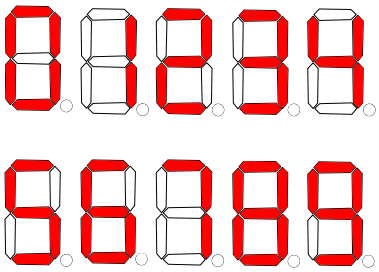
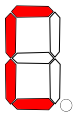
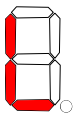
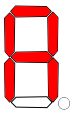
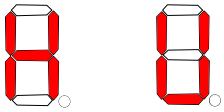
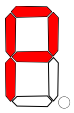
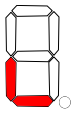
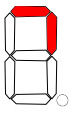


Fig. 20 Total step time example.

Most cameras do not require the external autofocus signal. In this you must set the atuofocus time to 0. **Always make sure to set autofocus to 0 when your camera does not support an external autofocus signal.**

4. Character display information

Pano360 is equipped with character, segment display (**Fig 1.-M**) that feeds back useful information regarding the device. Bellow is a complete list of all the characters and the functions/malfunctions they indicate.

Symbol	Description
	Numbers from 0 to 9 indicate the preset which is currently chosen. You can move through different presets by pressing the button on the side of Pano360 (**Fig 1.-N**) or by triggering a digital channel on your receiver (make sure the 3rd digital input is connected with the RC receiver (**Fig. 6**).
	Letter C (**C**urrent) – the current value has exceeded the Threshold and did not drop below the Threshold minus Hysteresis within the Time Limit (**3.2.2** / **Fig.17**) – as a result the motor has been turned off. This usually happens when the drive is blocked. Please make sure there is nothing in the way of the camera, check if the drive (pulleys, belt) is not blocked. This message can be also displayed if a heavy camera is used with aggressive acceleration, max. speed and deceleration parameters. If you are using a high payload make sure to adjust the overcurrent protection or lower the Acceleration, Deceleration and Max Speed Values (Fig. 11-E) to enable slower camera movement.
	Letter L (boot**L**oader) – the bootloader is active. The device is updating the firmware.
	Letter A – stop detection is in progress, the controller is waiting until the current value drops below the threshold and will remain below threshold + hysteresis for the specified time (**3.2.3** / **Fig. 19**) .
	Letter H or U letter – internal error, should you see this symbols make sure to write down what has happened before this message occurred. Contact us and provide a short description of the occurrence: contact@invendyne.com
	Letter P (**P**ower) – there is a problem with the motor power supply, the voltage is not within the desired range. This can happen due to a variety of reasons, for example: the battery voltage is too low, there is a short circuit, the power converter is damaged etc.
	Left, bottom corner – autofocus is active (**Fig. 20**).
	Right, top corner – shutter is active (**Fig. 20**).

Tab. 4 A complete list of the character display messages.

5. Additional information

Website

www.invendyne.com

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Acknowledgement

This product was developed using:

- ChibiOS 2.6.5 real time operating system, the source code can be found at:http://www.chibios.org
  ChibiOS/RT - Copyright © 2006,2007,2008,2009,2010,2011,2012,2013,2014 Giovanni Di Sirio.

- Qt aplication framework, the source code can be found at:http://www.qt.io/
  Qt is available under LGPL licence.
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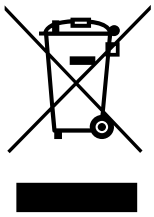
WEEE Warning



To avoid the potential effects on the environment and human health as a result of the presence of hazardous substances in electrical and electronic equipment, end users of electrical and electronic equipment should understand the meaning of the crossed-out wheeled bin symbol. Do not dispose of WEEE as unsorted municipal waste and have to collect such WEEE separately.

Revision

User's manual for Pano360 – automated panoramic gimbal revision 1.0 (September 2014).